NASA TECHNCIAL TRANSLATION

NASA TT F-13,839

NEW METHOD FOR INFORMATION PICK UP FROM SPARK CHAMBERS

Yu. A. Karzhavin, A. T. Matyushin, V. T. Matyushin M. N. Khachaturyan

Translation of "Novy sposob s'yema informatsii s iskrovykh kamer". Dubna, Joint Institute for Nuclear Research, Report P13-5016, 1970, 12 pages

(NASA-TT-F-13839) NEW METHOD FOR INFORMATION PICK UP FROM SPARK CHAMBERS Y.A. Karzhavin, et al (Scientific Translation Service) Jan. 1971 10 p CSCL 20C

N72-15620

(CATEGORY)

G3/23 11868

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546 JANUARY 1971

NEW METHOD FOR INFORMATION PICK UP FROM SPARK CHAMBERS

Yu. A. Karzhavin, A. T. Matyushin, V. T. Matyushin, M. N. Khachaturyan [1]

ABSTRACT. A method is described for the passive location of an ultrasonic signal generated by a spark in the chamber electrode. The materials employed and the circuit diagrams are presented.

The method [1] described in this study, involves the passive location of an ultrasonic signal, generated by a spark in the electrode proper of the chamber. In our experiments, we have used a piezoelectric detector (the piezoelement of an industrial sound transducer,) even though it is apparently also feasible to use a magnetostrictive sound transducer, connected to the electrode by means of magnetostrictive material. /3*

The piezoelement jointly with the emitter-follower were mounted in a completely screened box-type transducer made of aluminum. The box-type transducer dimensions were 18 x 18 x 25 mm^3, with a coaxial slit. The transducer was either pressed directly upon the chamber electrode, or upon the acoustic line (foil, plate), which, in turn, was pressed against the chamber electode. A theoretical diagram of the electrical circuit of the transducer is shown in Figure 1. The piezoelement can be also connected directly with a cable, without the emitter-follower, but that makes the signal amplitude considerably smaller.

*** Numbers in the margin indicate the pagination of the original foreign text.**

1. Laboratory of Computation Technology and Automation and Laboratory of High Energies

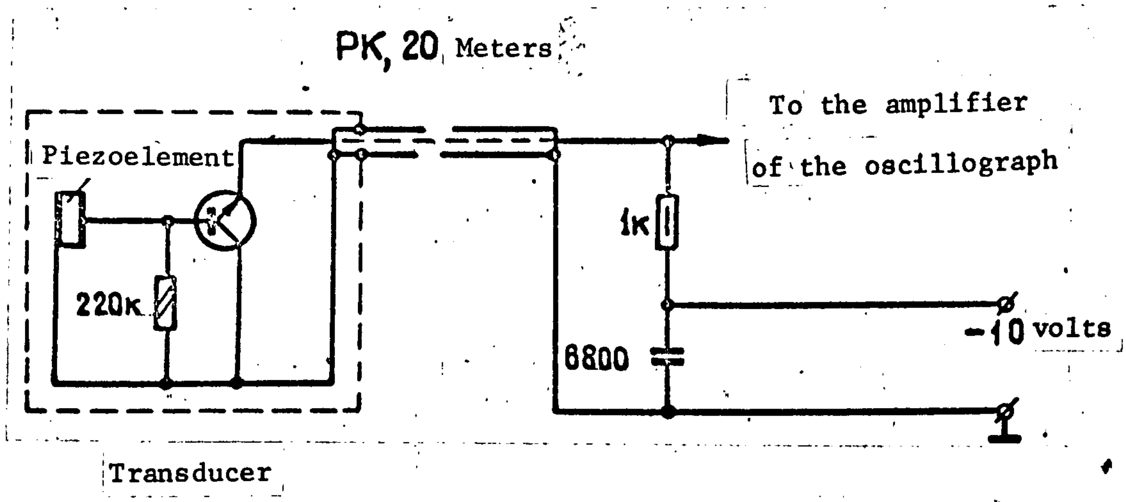

Figure 1. Theoretical electrical diagram of the transducer.

In our experiments, we used a high voltage generator GIN1-T-25/6 with a 20 m cable. This installation was described in [2].

The amplitude of the recorded signal depends on the electrode material, the thickness of the electrode, the distance between the transducer and the spark, the spark energy, the length of the spark gap (when sparking takes place in air), and the acoustic matching of the piezoelement with the acoustic line, or with the chamber electrode.

The most appropriate of the conventionally used materials is dural, and particularly foil. Figure 2 shows the relationship between the transducer signal amplitude U_c and the length of the air gap during sparking upon an 0.9 mm thick dural plate, against which the transducer was pressed: Figure 3 shows the relationship between the signal amplitude U_c and the amplitude of the high voltage pulse (voltage on the anode of the thyratron) with constant gap and two values of the charge capacitance of the generator. In both instances, the distance between the spark and the transducer was 50 mm. /4

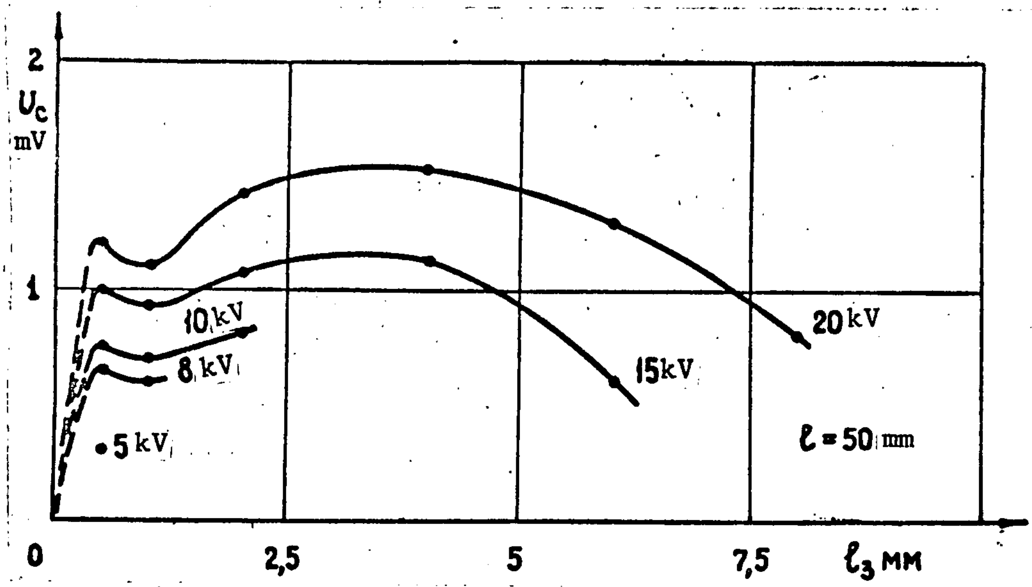

Figure 2. Relationship between the amplitude of the transducer signal, and the length of the air gap at different voltages on the thyratron anode of the high-voltage generator.

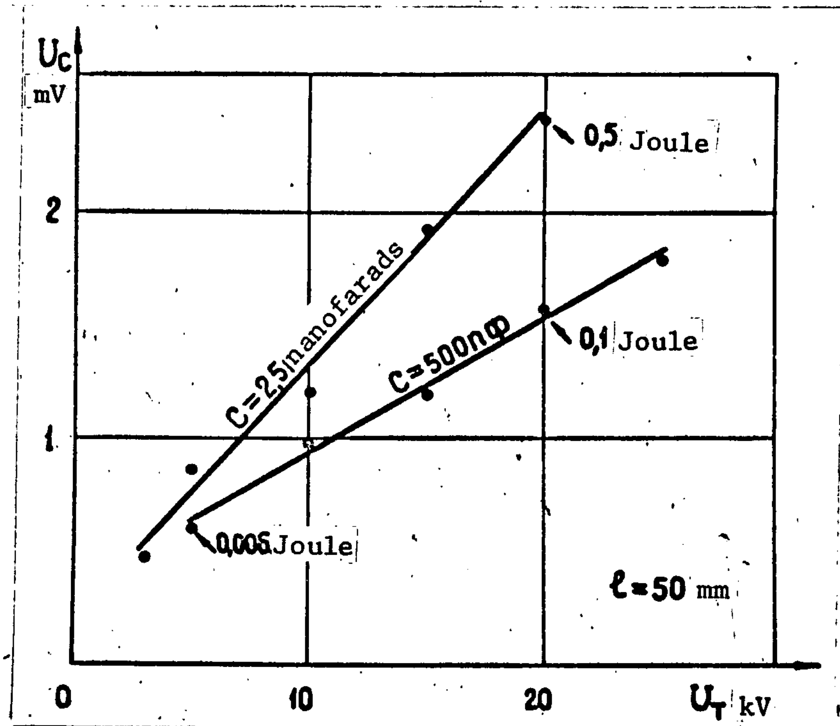

Figure 3. Relationship between the transducer signal amplitude, and the voltage on the thyratron anode at constant gap and two values of charge capacitance.

When a dural foil (0.1 mm thick) was used instead of the plate, the amplitudes of the signal went up by almost a whole order of magnitude.

To register the signal of the track of the particle, we used a spark chamber described in [3]. The dimensions of the chamber were 60 x 60 x 10 cm^3 with solid electrodes, made of 0.9 mm thick dural plates; the chamber was started from cosmic particles, using the same generator of high voltage pulses. The sparks were weaker, and the field intensity in the chamber did not exceed 4.5 - 5 kilovolt/cm.

Figure 4 shows the relationship between the signal amplitude of the transducer U_c from ℓ to the spark. Curve 1 shows the sparking in air upon the electrode of the chamber (thyratron voltage U_T = 20 kilovolt); Curve 2 shows the track in the chamber when U_T = 25 kilovolts. The same illustration shows the oscillogram of the signal U_c (track). The scanning rate is 1 microsecond/cm, and the sensitivity of the whole amplification track is 2 milivolt/cm. The distance to the spark is 326 mm. The synchronization circuit of the oscillograph included a compensating delay.

While the spark generates oscillations of various types in the dural plate, for location purposes, it is feasible to use essentially oscillations with propagation rates of 5.5 and 3.2 mm/microsecond, whereby the mean frequency [4] of the first signal is higher and amounts to a magnitude of the order of a megahertz. With good acoustic matching, the shape of the output signal is close to optimal and is a result of the reaction of the piezoelement upon the uni- /5
polar impulse [4]. The compensation time constant depends essentially upon the intensity of the relatively low frequency oscillations of the plate acting as a membrane and, in absence of absorbers, amounts to, on the order of 10 microseconds, (with the foil, it is 1 to 1.5 microseconds). When a frequency-selective amplifier is used, it is possible to tune to the reception of either the first signal (v_1 = 5.5 km/sec), or of the other signal v_2 = 3.2 km/sec.).

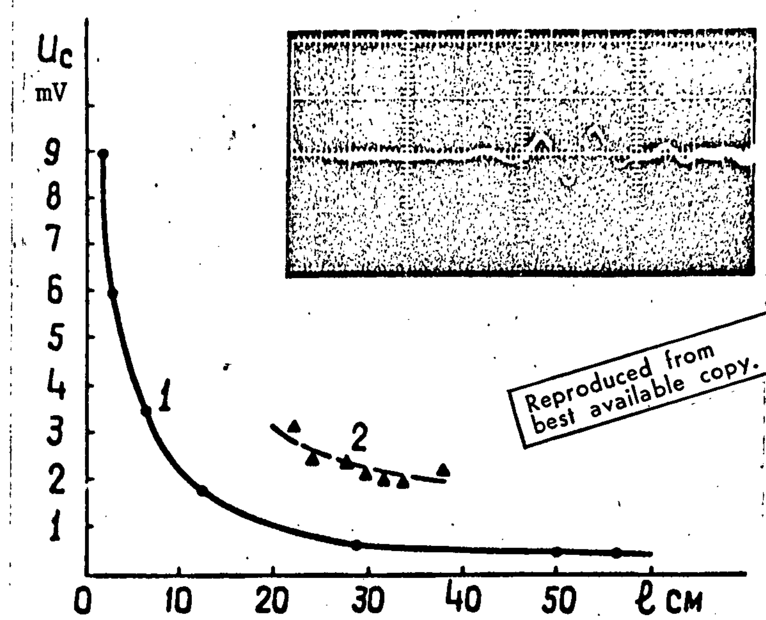

Figure 4. Signal amplitude as a function of the distance between the spark and the transducer:

1. sparking in air; 2. track in chamber. Oscillogram of signal from track at ℓ = 326 mm. Sensitivity of amplitude track: 2 millivolt/cm; scanning rate: 1 microsecond/cm.

In the course of experiments, we noted an interesting effect: The ultrasonic signal was generated when a high-voltage pulse was applied to a needle, pressed with its point either directly upon the plate, or through a mylar film of such thickness that a breakdown could not possibly occur. In the first instance, this phenomonen can be explained by the presence of a layer of oxides ("the barrier layer"); in the second instance, — by the action of the electrodynamic impact of the system film-electrodes.

The described method of information transducer from spark chambers is relatively simple and has a number of advantages: The "ends" of the spark are registered in the gap; the transducer is not electrically connected with the chamber and is easily removed (actually, the chamber and the transducer system are independent); the propagation rate of the signals is constant and it is possible to "transduce" (x, y) coordinates from one electrode. Moreover, the method can be used in the operation of chambers in a magnetic field and is applicable for chambers of any geometry, with large as well as with small gaps; it can be used in film cameras along with photography, which is particularly convenient for a preliminary selection of the frames.

The design and development of a "high transmission" device, using spark chamber methods on an accelerator, requires spherical geometry of the spark detector, i.e., a spherical spark chamber with the target in the center. When is is necessary to perform a γ-quanta registration, the chamber must consist /6 of several gaps, separated by γ-converters. It is considerably easier to generate a raised pressure in a spherical chamber, as compared to other chamber designs. At the same time, the chamber walls can remain thin, thus allowing the chamber dimensions to decrease and to improve the localization accuracy of the sparks. To attain spherical geometry, the electrodes of the chamber should be designed in the form of hemispheres with appropriate radii, whereas the transducers should be located along the edges of the electrodes.

Figure 5 shows a structural layout of such an installation for the accumulation and partial processing of information. In view of the large quantity of transducers in this installation (20 to 30, and more), and the relative complexity of the equipment, it seems that the most feasible method of obtaining information is the use of a small electronic computer or time-sharing with a large computer that has the necessary characteristics.

The task of the electronic computer includes accumulation of information when the beam hits the target, and partial processing of the information during pauses. The rate of information received during the target period is not less than 10 - 20 words during the time that equals the dead time of the chamber. The dead time of the chamber is approximately 5 microseconds for chambers with foil electrodes. Thus, the time of receipt of one digit by the electronic computer must be less than 250 microseconds, the digital order of the word being 11 - 12 bits.

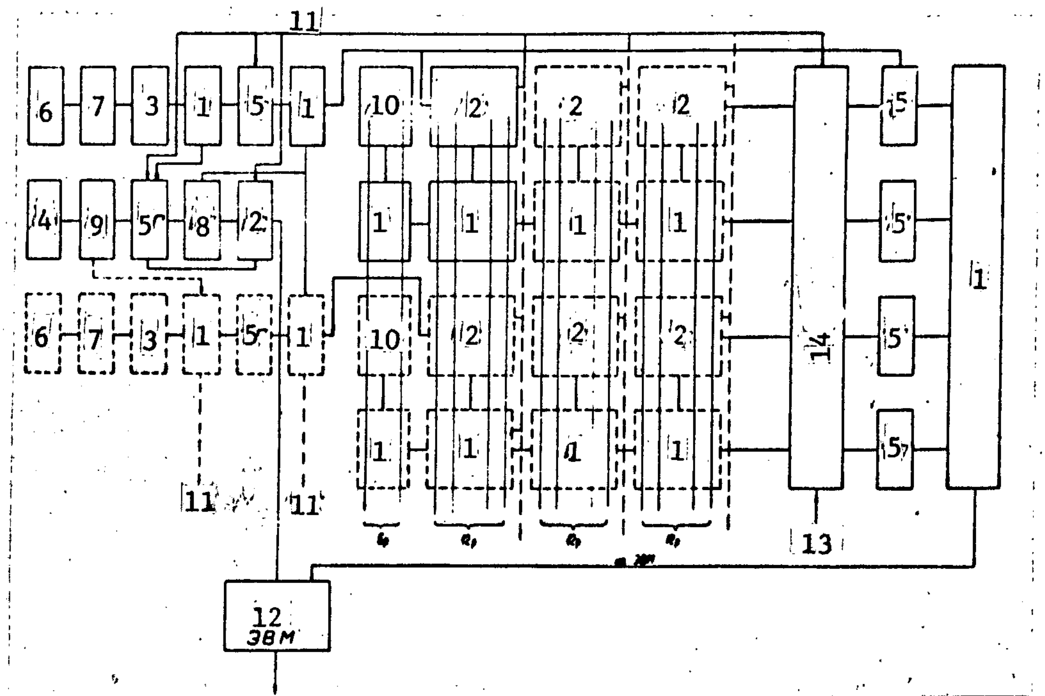

Figure 5. Structural layout diagram of the communication channels to the electronic computer.

Key: 1. and; 2. scaling circuit; 3. pulse shaper; 4. generator of impulse; 5. trigger; 6. transducer; 7. amplifier; 8. impulse generator; 9. phase delay; 10. synchronization*; 11. illegible; 12. electronic computer; 13. query; 14. communicator.

Machines of the type BESM-4, M-220, Dnepr-1, Dnepr-2, Minsk, and others, are suitable for this type of installation. The readout channel is designed following a diagram that is similar to the ones that are widely used in the technology of ultrasonic and acoustic chambers.

For registration and storage of the information, it is advisable to use scaling circuits -- Figure 5. The channels of signal processing are identical for all transducers and consist of an amplifier, pulse shaper, and a trigger.

---

* Translators' note: This has not been clearly defined in the text.

The trigger allows the receipt of reference pulses from the pulse generator with a frequency of approximately 10 megahertz upon the scaling circuits, when the chamber is started by the pulse generator. Triggers in the information processing channels are started by the "AND" circuits which prohibit the passage of signals before the chamber is started.

The information transducer in a computer follows an instruction from the scaling device which reads off the maximum time of signal propagation in the electrodes of the chambers. The transducer of the digits follows a "Digit Request from Computer" instruction.

The trigger and the "AND" circuit, connected to the commutator, register the presence of information in the scaling circuit; in the absence of information in the scaling circuits, the "AND" circuit transmits an appropriate signal into the machine. All trigger circuits of the system can be cleared into zero position either from the computer, or from the commutator.

The structural diagram shows the transmission of a 42-digit word into the computer in the form of a parallel code, whereby 6 digits are reserved for service information.

The structural diagram of the installation, consisting of 8 to 10 hemispheres (with the capability of registering 2 - 3 sparks per gap), shows that using industrial micromodular elements, the communication equipment for the machine can be located in one standard stand.

REFERENCES

1. Karzhavin, Yu. A., A. T. Matyushin, and V. T. Matyushin. OIYaI (Ob'yedinennyy institut yadernykh issledovaniy: Joint Institute of Nuclear Research). Preprint. Dubna, 13-4527, 1969.

2. Matyushin, A. T., V. T. Matyushin, R. Firkovskiy and M. N. Khachaturyan. PTE (Pribory i tekhnika eksperimenta). No. 2, 1968, p. 119.

3. Matyushin, A. T., V. T. Matyushin, R. Firkovskiy, M. N. Khachaturyan, and M. S. Khvastunov. Pribory i tekhnika eksperimenta. No. 2, 1968, p. 51.

4. Meson, U. (editor). Physical Acoustics. Vol. I, Part A. Translated from English. Mir Press, Moscow, 1966.

Manuscript received by the editors on 27 March 1970.

Translated for Goddard Space Flight Center, under Contract No. NASw-2035, by SCITRAN, P. O. Box 5456, Santa Barbara, California, 93103.